ENGINEERING ELECTROMAGNETICS

EP440, Fall 2018

ERAU Daytona Beach Campus
M/W/F, 2:00-2:50
Room: CoAS 125

Instructor: Jonathan B. Snively
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Phone: (386) 226-6306
Office: 319.21 (CoAS Building)
Office Hours: M 12-1PM; F 3-4PM.

Textbook: D. K. Cheng, Field and Wave Electromagnetics, 2nd Edition, Chapters 1-8, 9, 10?
Prerequisites: CS223, MA442 (Co-Req.), PS228/PS250, PS303, and PS320.
Canvas will only be used for mass emails and the posting of textbook solutions –
The most important course materials will instead be posted on the course website!

Homework/Project assignments will be posted on the website or announced in class. You may work on homework problems in groups or individually. You must show all details of solutions, cite all sources used, and list any collaborators. Assignments should be submitted on paper for the grader and scanned as PDF to email to Dr. Snively.
Late assignments will be graded at 0.75 credit if submitted before the next exam, 0.5 after.
All **Exams** are closed book and closed notes. Calculators are neither required nor allowed.
The **Final Exam** will be comprehensive and is officially scheduled for 12:30-2:30PM on Saturday, December 8th.

Weighting:

Homework	15%
Project	5%
Exam #1 (9/28)	25%
Exam #2 **(11/7)**	25%
Final Exam (12/8)	30%
	Total = 100%

Probable Grading Scale:

A	90 ≤ your grade
B	75 ≤ your grade < 90%
C	60 ≤ your grade < 75%
D	50 ≤ your grade < 60%
F	your grade < 50%

Grading: I reserve the right to apply beneficial curves, including to adjust grade scales, brackets, or weightings of materials to maintain an appropriate and fair distribution of grades.

Academic Integrity: *Cheating, plagiarism, and fraud are unacceptable in all forms, constituting serious academic integrity violations.* In accordance with Departmental and University policies, they can result in a failing grade or dismissal from the University.

Class Policies: iPads, food, beverages, etc. are allowed *only* if used with zero distraction to yourself and to others. Please *ask* before using a laptop in class (keyboards are noisy, screens distracting to others). Attendance will not be taken; you are fully responsible for *all* materials presented in class, including any assignments or announcements made.

> **A Message from DSS:** *ERAU is committed to the success of all students. It is University policy to provide reasonable accommodations to students with disabilities who qualify for services. If you would like to request accommodations due to a physical, mental, or learning disability, please contact the Disability Support Services Office at 226-7916 located on the West side of the Wellness center – Building #20. All discussions are confidential.*

Textbook-Specific Course Topics / Outline in Support of Outcomes (*see next page)*:

1. Integral and Differential Forms of Maxwell's Equations (Chapter 1-2)
   - **a.** Mathematics (calculus) of vector fields.
   - **b.** Integral and differential forms of Maxwell's Equations.
   - **c.** Maxwell's Equations and the Lorentz force in classical electrodynamics.
2. Electrostatics (Chapter 3-4) / Steady Current (Chapter 5) / Magnetostatics (Chapter 6)
   - **a.** Maxwell's Equations for electrostatic and magnetostatic fields.
   - **b.** Electric fields by integration and by symmetry arguments using Gauss's law.
   - **c.** Poisson's and Laplace's equations for useful geometries.
   - **d.** Method of Images to determine electric fields.
   - **e.** Dipoles, dipole fields, and dipole moment vectors.
   - **f.** Polarization, permittivity, and the relationship between **D** and **E** fields.
   - **g.** Magnetization, permeability, and the relationship between **B** and **H** fields.
   - **h.** Electric potential V and magnetic vector potential **A**.
   - **i.** Magnetic fields by Ampere's Law and the Biot-Savart Law.
   - **j.** Capacitance for simple configurations of electrodes.
   - **k.** Mutual and self-inductance for simple coil geometries.
   - **l.** Energy storage in electric and magnetic fields.
   - **m.** Electric and magnetic forces.
   - **n.** Boundary conditions for **E**, **D**, **B**, and **H** fields in media.
3. Electrodynamics (Chapter 7)
   - **a.** Faraday's Law for induction and motional emf.
   - **b.** Maxwell-Ampere law and displacement current.
   - **c.** Complex phasor time-harmonic solutions and application to Maxwell's equations.
   - **d.** Electromagnetic wave equation from Maxwell's Equations, including for V and **A**.
4. Electromagnetic Waves (Chapter 8)
   - **a.** Complex time-harmonic wave representations to describe EM waves.
   - **b.** EM wave parameters (wavenumber, frequency), wave energy (Poynting flux), wave impedance, and polarization.
   - **c.** Propagation of plane waves in unbounded linear media.
   - **d.** Wave propagation and attenuation in conducting media; group and phase velocity.
   - **e.** Reflection and refraction at interfaces.
5. Transmission Lines, Waveguides and Cavities (Chapter 9.2 / Chapter 10, *as time permits*)
   - **a.** TEM propagation on parallel-plate transmission lines.
   - **b.** Transmission line circuit parameters.
   - **c.** TE and TM mode propagation between parallel-plates and rectangular waveguides.
   - **d.** TE and TM modes of rectangular cavities.

This list is provided to show the approximate chronology of material; the course content and its textbook are in full accord with the ERAU Master Course Outline, Goals, Description, and Learning Outcomes (see next page).

Learning Outcomes (from ERAU Master Course Outline):

1. Quantitatively comprehend the basic physical principles, which govern the interactions among charges at rest as well as charges in motion, and the effects of external electromagnetic systems.
2. Compute the electrostatic fields for various charge distributions using Gauss' law.
3. Apply the method of images to derive the electric field due to point charges placed near extended conducting media.
4. Quantitatively analyze the consequences of the non-rotational nature of electrostatic fields to derive a mathematical relation between the spatial variations in electrostatic potentials and their sources.
5. Apply special analytic techniques (such as solving 2-D partial differential equations in various coordinate systems), use of Fourier series and Legendre series.
6. Quantitatively analyze the effects of external electric field on conductors and insulators, in particular on linear dielectrics.
7. Calculate bound surface and volume charge densities due to polarization in media of different geometries.
8. Compute the magnetic field in all space due to different configurations of line, surface and volume current distributions using Biot-Savart law. Use Ampere's law to calculate the magnetic field due to symmetric current distributions.
9. Quantitatively analyze the effects of solenoidal nature of magnetic field to derive the magnetic vector potential.
10. Use the Lorentz force law to study the kinematics of charges moving in magnetic fields.
11. Quantitatively explore the effects of magnetic field on paramagnetic, diamagnetic and ferromagnetic materials.
12. Calculate bound surface and volume currents in magnetic media of different magnetization.
13. Explore the relation between solenoidal electric and magnetic field to derive motional emf.
14. Synthesize the totality of physical principles governing electrostatics, magnetostatics and electrodynamics to derive Maxwell's equations.
15. Formulate electrostatics and electrodynamics in terms of scalar and vector potentials.
16. Demonstrate the concepts of energy and momentum in electrodynamics and apply them to electromagnetic waves.
17. Use Maxwell's equations to derive the electromagnetic wave equation and solve it for waves in dielectric and conductive media. Apply the results to explore the propagation of electromagnetic wave in all media using time-harmonic forms.
18. Apply knowledge of college-level mathematics for defining and solving problems.
19. Understand some of the important results of scientific inquiry in the natural and life sciences, and use scientific information in critical thinking and decision-making.
20. Use technology to organize and manipulate information to communicate ideas and concepts.
21. Compute capacitance and inductance of simple arrangements of conductors
22. Understand and compute electric and magnetic fields produced by electric and magnetic dipoles, respectively.
23. Understand the behavior of electromagnetic fields, including wave transmission and reflection, at the boundaries between different media.
24. Apply basic electromagnetic principles to understand electromagnetic transmission systems like transmission lines and waveguides.